

## Overview of Atomic Layer Etching – From the Ion Beam Perspective

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Atomic layer etching (ALE) is a promising technology for atomic scale fidelity needed for manufacturing of integrated devices of the 10-nm node and below. It is being driven by the semiconductor industry as an alternative to continuous etching and is viewed as an essential counterpart to atomic layer deposition (ALD). In analogy to ALD, ALE is characterized by the cyclic application of multiple process steps that are as “self-limiting” as possible. Types of self-limited processes include surface activation, adsorption, desorption, passivation, oxidation, and ion damage range. Thus, ALE encompasses a wide variety of etching schemes including reactants delivered by gases, plasma, liquid chemistry, or other sources. In some implementations of ALE utilize a removal step to provide energy to overcome bond strengths for removal of the modified layer from previous step(s). The source of energy for the removal step can be chemical, thermal, or bombardment (such as ion, photon, or electron). This presentation is an introduction of the basics of ALE field, with focus on directional etching by ion bombardment in the removal step or the activation step.

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